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Multi-material polyjet printing for more lifelike endodontic practice teeth

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1 | PROBLEM

Root canal therapy is a highly technical procedure that has several unique challenges. Extracted human teeth have traditionally been used to train dental students which have come under increased scrutiny in recent years.[1] Multiple published studies have demonstrated the value of three-dimensional (3D) printed teeth for dental education.[2–5] A limitation common to these publications has been the inability to 3D print using multiple materials simultaneously.[3] One strategy for creating a multi-material tooth was to create a tooth with a hollow pulp chamber and cavity preparation that was later filled with impression material and resin composite, respectively.[2]

2 | SOLUTION

Polyjet printing that allows for the use of six materials with different colors and physical properties was used to create endodontic practice teeth that had a white enamel layer, an A2 shaded dentin and root structure as well as a hollow, red pulp chamber full of a water-soluble, gelatinous support material (J5 Dentajet; Stratasys). A cone beam computed tomography (CBCT) radiograph of an extracted maxillary first premolar was made (75 μm, 90 kV, and 10.0 mA). The pulp chamber and canals were segmented from the reconstruction and Standard Tesselation Language files of the pulp chamber and tooth were exported. A 3D modeling program (Meshmixer, Autodesk) was used to further segment the file into an enamel layer, a dentin and root layer, and a hollow pulp chamber (Figure 1). These three files were brought into the printing software (GrabCAD; Stratasys) as an assembly which allows for the selection of different materials to be printed simultaneously in a single object. The enamel layer was printed using a white resin, DEN847 VeroDent PureWhite, an A2 shade resin for the root layer, MED620 VeroGlaze, the hollow pulp layer was printed using a red resin, RGD 852 VeroMagenta-V, and the hollow cavity of

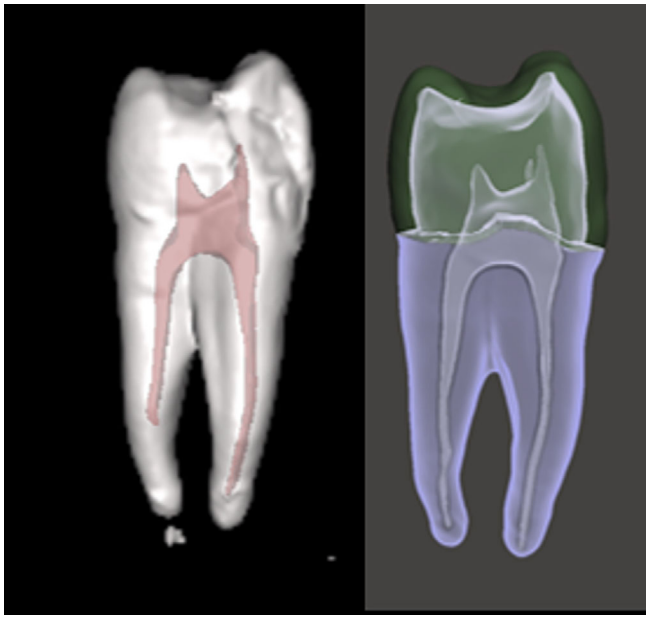

FIGURE 1 Cone beam computed tomography (CBCT) and segmented Standard Tesselation Language (STL) files.

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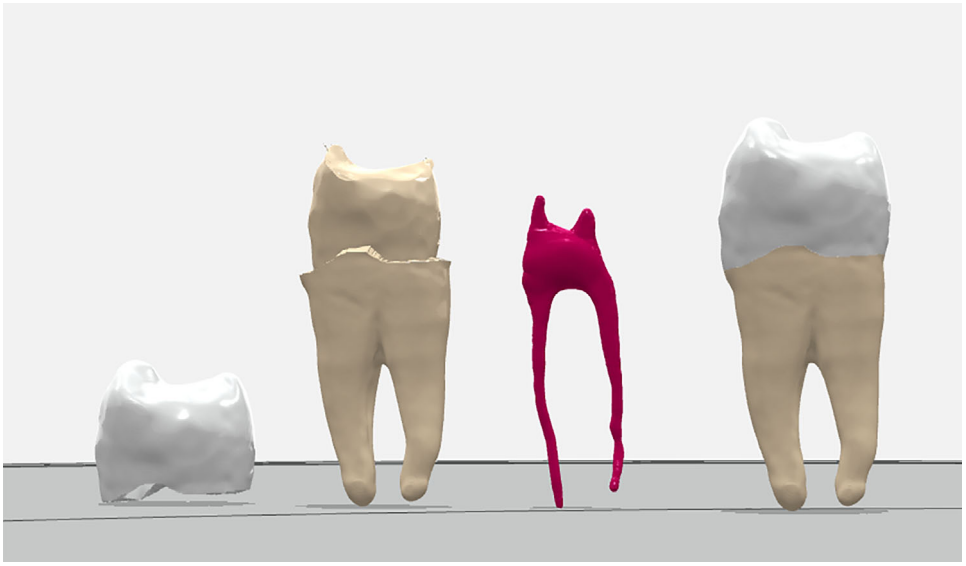

FIGURE 2 Assembled and disassembled parts for polyjet printing.

FIGURE 3 Final printed teeth.

the pulp layer was printed with SUP711. Figure 2 shows the three layers assembled into a single item as well as disassembled into its three constituent parts.

3 | RESULTS

PolyJet printing was capable of fabricating endodontic practice teeth with multiple textures throughout the printed item. Figure 3 shows the printed teeth in cross-section and whole demonstrating the three solid materials and the gelatinous material filling the pulp chamber and canals. The canals can be filed with endodontic files and the gelatinous support material removed in a similar fashion to the pulp tissue. The initial expense of 3D printing technology can be high as identified by several authors.[3] The use of the described technology in this article was able to produce 100 of the practice teeth in an overnight printing cycle for a per-tooth cost of less than half of one US dollar. With the ease of producing segmented files from a CBCT image of a tooth and the low cost of printing, students can be given greater access to standardized practice teeth for endodontic education. This same process has been applied by the author to design and create practice teeth with soft, excavatable carious lesions for a similarly low cost per tooth.

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